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Road vehicles — Intelligent power switches —

Part 1: High-side intelligent power switch

Véhicules routiers — Sectionneurs de puissance intelligents —

Partie 1: Sectionneur de puissance intelligent en version d'amont

Reference number
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Foreword

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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10483-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This second edition cancels and replaces the first edition (ISO 10483-1:1993), which has been technically revised. A new schematic and tolerances appropriate to test parameters and test equipment have been introduced. The test circuits have been revised according to ISO 12343, with the general test circuits, as well as test models, being considered in Annexes C to E.

ISO 10483 consists of the following parts, under the general title *Road vehicles — Intelligent power switches*:

— *Part 1: High-side intelligent power switch*

— *Part 2: Low-side intelligent power switch*

Road vehicles — Intelligent power switches —

Part 1: High-side intelligent power switch

1 Scope

This part of ISO 10483 specifies the minimum requirements for high-side intelligent power switches (HSIPS) installed on road vehicles with 12 V or 24 V nominal supply voltage. These switches are intended primarily for automotive applications (lamps, motors, relays, etc.).

The numerical values in parentheses refer to 24 V nominal vehicle supply voltage systems.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7637-1, *Road vehicles — Electrical disturbances from conduction and coupling — Part 1: Definitions and general considerations*

ISO 7637-2, *Road vehicles — Electrical disturbances from conduction and coupling — Part 2: Electrical transient conduction along supply lines only*

3 Terms and definitions

For the purposes of this part of ISO 10483, the following terms and definitions apply.

3.1
intelligent power switch
IPS
single solid-state on/off switch with self-protection, functional status information and positive logic level input

3.2
high-side intelligent power switch
HSIPS
single solid-state on/off switch whose switching part is between the positive supply and the load, and having self-protection and automatic recovery, functional status information and positive logic level input

3.3
free air conditions
conditions under which the component is used without additional heat sink and forced cooling

3.4
rated current
I_{rate}
current causing a voltage drop of 0,5 V across the power supply pin and the load pin, at specified case temperature and at the supply voltage of the system

NOTE Rated current is defined only for a consistent comparison between devices from different sources. In use, the voltage drop will depend on the application.

3.5
maximum continuous current
I_{max}
maximum current which does not activate self-protection at a specified case temperature and at the supply voltage of the system

3.6
overcurrent
I_{ov}
minimum current which causes the switch to change from its normal function to a self-protection mode of operation

3.7
supply quiescent current
I_{sq}
current flow at a short-circuit of the load, with the switch in the self-protecting mode, the status output an open circuit and the input grounded

3.8
inductive load at rated current
L_{rate}
maximum inductance connected in series with a specified resistance which can be driven without freewheel diode

3.9
inductive load at maximum current
L_{max}
maximum inductance connected in series with a specified minimum resistance which can be driven without freewheel diode

3.10
propagation delay time at open load
t_{pol}
duration between the falling edge of the input signal and the rising edge of the status signal, at permanent open load and under given conditions

3.11
propagation delay time at overload
t_{povl}
duration between the falling edge of the input signal and the rising edge of the status signal, at overload

3.12
open load condition
I_{ol}
condition under which the current is less than the threshold current

3.13
overload condition
condition under which the switch is in the self-protected state

3.14
thermal protection
ability of the switch to protect itself against over-temperature by switching off the load current

4 Main characteristics

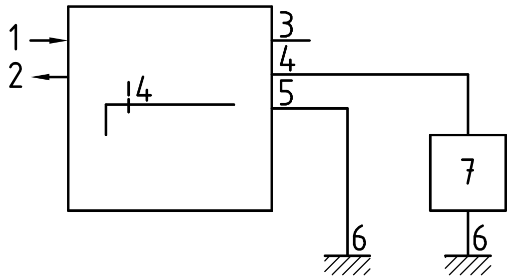
4.1 Switch description

The HSIPS shall have two main functions:

a) the switching function;

b) the protection of the switch and of the connected circuit, indicated by a single status bit information of the state of the load of the switch.

The switch shall be a five-pin component, as shown in Figure 1.



Key

Terminals of HSIPS

1 input
2 status
3 power supply
4 to load
5 Ground

Connected functions

6 Common return
7 Device to be switched, forming a load of the HSIPS

Figure 1 — HSIPS main functions

4.2 Functions

4.2.1 Input

4.2.1.1 Description

Logic “0” on the input shall cause the off state of the switch.

Logic “1” on the input shall cause the on state of the switch, except in overload conditions.

The switch shall be also in the off state when the input is not connected.

For the truth table, see Annex A.

4.2.1.2 Trigger levels

The trigger levels shall be as given in Table 1.

Table 1 — Trigger levels

Parameter	**Triggering level** V	
	min.	max.
U_{t-}	0,8	—
U_{t+}	—	2
Hysteresis $(U_{t+}) - (U_{t-})$	0,5	—

4.2.1.3 Pull-down impedance

The pull-down impedance of the input shall be between 10 kΩ and 50 kΩ.

4.2.2 Status

4.2.2.1 Description

The status output type shall be an open drain or an open collector.

When the input is at logic ”1”, the status bit indicates with logic “0”, which indicates

a) an open load circuit, or

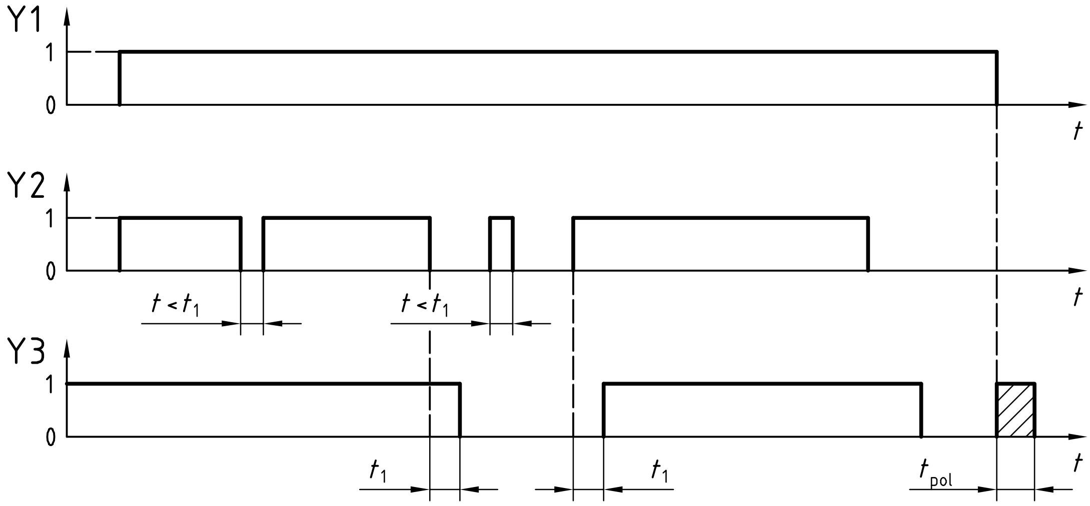
b) an overload condition,

corresponding to a low impedance of the status output to Ground.

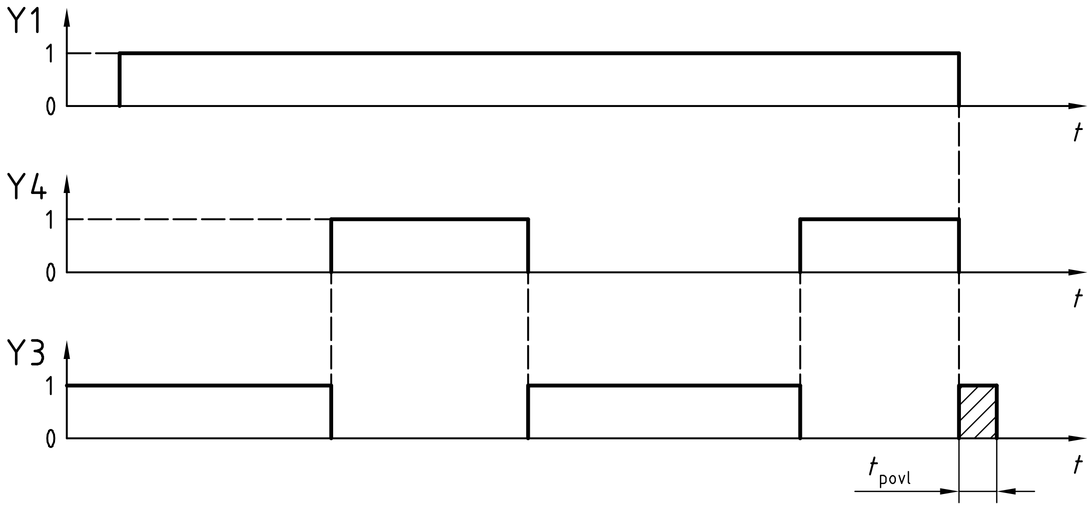
Otherwise, the status bit is at logic “1”, which corresponds to a high impedance of the status output to Ground.

For a description of status information at open load and overload, see Figure 2.

For the truth table, see Annex A.



a) Open load



b) Overload

Key

t time

Y1 input

Y2 load current, *I*

Y3 status

Y4 overload, *I*

Figure 2 — Description of status information

4.2.2.2 Requirements

4.2.2.2.1 Output levels

The status output shall show the following characteristics within the case temperature range as specified in 4.4.7:

a) maximum output voltage of 0,4 V at logic “0” and a sink current of 1,6 mA;

b) minimum clamp voltage of 5,5 V at a status leakage current below 0,1 mA.

4.2.2.2.2 Open load operation

The open load condition is indicated by logic “0” on the status pin when it lasts longer than t_1 (1 ms < t_1 < 10 ms) (see Figure 2).

The status signal shall return to logic “1 “ when the open load condition ended for longer than t_1.

For the truth table, see Annex A.

4.2.2.2.3 Overload operation

Any operation at overload shall be indicated by logic “0” on the status pin, as soon as the switch is in the self-protected state, i.e. the switch is at overload condition.

For the truth table, see Annex A.

4.2.2.3 Discrimination between overload and open load

4.2.2.3.1 With external components

With external components it shall be possible to use the output of the status pin in conjunction with other information to differentiate between open load and overload. In this case, t_{pol} and t_{povl} (see Figure 2) are of the same order of magnitude.

4.2.2.3.2 Internally

If a feature is implemented within the device in order to distinguish between overload and open load, it shall be by means of an increase of t_{pol}. In this case, t_{pol} shall be much greater than t_{povl}.

4.3 Package and contact allocation

4.3.1 Package 1

If a TO 220 or TO 218 package is used (Package 1), the pin allocation given in Table 2 is recommended.

Table 2 — Pin allocation (Package 1)

Pin number	Use
1	Ground
2	Input
3	Power supply
4	Status
5	Load

4.3.2 Package 2

If a TO 220 or TO 218 Grounded case package is used (Package 2), the pin allocation given in Table 3 is recommended.

Table 3 — Pin allocation (Package 2)

Pin number	Use
1	Power supply
2	Input
3	Ground
4	Status
5	Load

4.4 Operational requirements

4.4.1 Power supply voltage ranges

The switch shall be in accordance with Table 4.

Table 4 — Power supply voltage ranges

Voltage V	Justification	Comment/Requirement
> 50 (> 75)	Coupling of spurious spikes (see ISO 7637-1 and ISO 7637-2)	The switch shall be capable of being protected by external devices.
30 to 50 (40 to 60)	Clamped load dump	Protection of the switch takes priority over the functionality.
22 to 30	Voltage surge on cut-off inductive loads	Operation ensured in degraded mode (on resistance).
16 to 22 (32 to 40)	Jump start or regulator degraded	Operation ensured in degraded mode (on resistance).
10,5 to 16 (18 to 32)	Normal operation condition	Operation to rated design specification.
8 to 10,5 (12 to 18)	Alternator degraded	Operation ensured in degraded mode (on resistance).
6 to 8 (6 to 12)	Starting phase, petrol engine	Operation ensured in degraded mode (on resistance).
0 to 6 (0 to 6)	Starting phase, compression-ignition (diesel) engine	Capability of being switched off and of staying in off state when the input goes low.
< 0	Negative peaks or inverted battery (see ISO 7637-1 and ISO 7637-2)	The switch shall be capable of being protected by external devices.

4.4.2 Rated current

The rated current, I_{rate}, shall be measured under the following conditions.

a) Power supply voltage: 13,5 V ± 0,5 V (27 V ± 1 V).

b) Power supply characteristics: in accordance with Annex B.

c) Case temperature (85 ± 2) °C, using an external heat source.

4.4.3 Quiescent current

The supply quiescent current, I_{sq}, shall be below 10 µA at a supply voltage of 13,5 V ± 0,5 V (27 V ± 1 V), measured at a case temperature of (85 ± 2) °C.

4.4.4 Maximum continuous current

The maximum continuous current, I_{max}, shall be measured under the following conditions.

a) Power supply voltage: 13,5 V ± 0,5 V (27 V ± 1 V).

b) Power supply characteristics: in accordance with Annex B.

c) Case temperature (85 ± 2) °C, using an external heat source.

Increase the current flow slowly to maintain equilibrium until the thermal protection is operating.

Repeat this at a current just below the protection threshold and measure the current (which is the maximum continuous current) and the voltage drop across supply and load terminals (U_{Lmax}).

Semiconductor manufacturers shall specify this voltage drop, U_{Lmax}.

4.4.5 Overcurrent

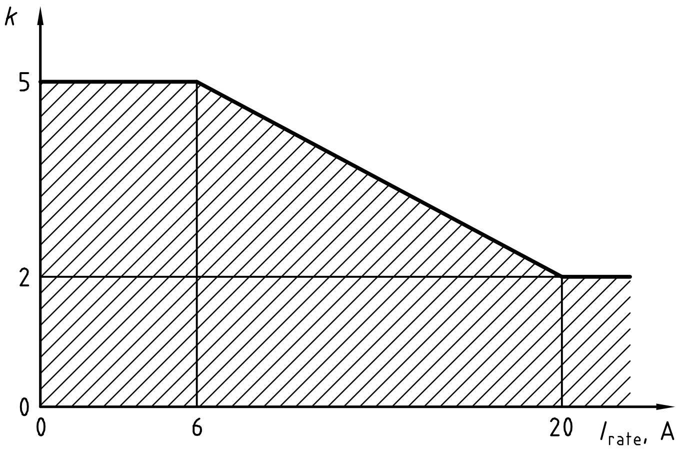
The overcurrent is the current where the self-protection of the switch is effective, e.g. by current limitation implemented in the switch (not mandatory).

Figure 3 illustrates the relation of current to type of load, where the overcurrent lies above the shaded area.

EXAMPLE 1 For a bulb requiring a 6 A HSIPS, the minimum current limitation shall exceed 30 A for response time problems (k = 5).

EXAMPLE 2 For a d.c. motor requiring a 20 A HSIPS, the minimum current limitation shall exceed 40 A to ensure correct surge response (k = 2).

An implication of the concept of overcurrent is that, when the switch is operating with the load models according to Annexes C to E, the output shall not operate in a chopping mode, and the status pin shall not indicate an overload.

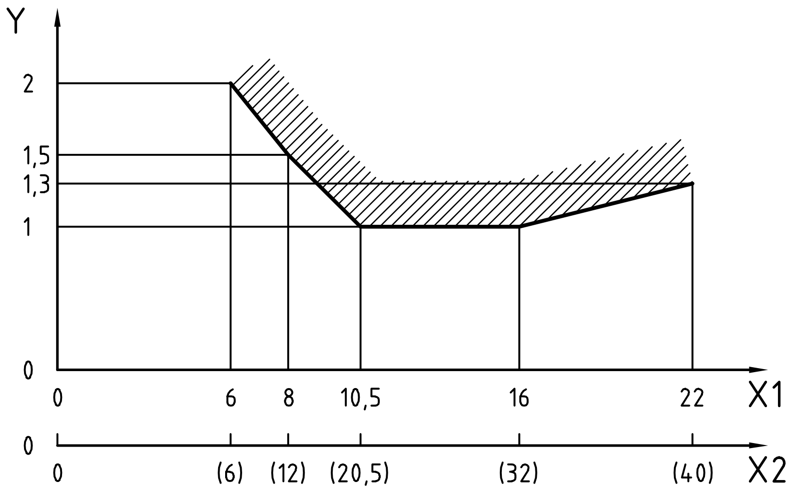


$$I_{ov} > k \times I_{rate}$$

Figure 3 — Current versus load type

4.4.6 Variation of on resistance

The variation of the on resistance, R_{on}, versus the power supply voltage shall be in accordance with Figure 4, in respect of measurements at rated current with a resistive load and at a case temperature of (85 ± 2) °C.



Key

X1 voltage, V; 12 V nominal supply voltage application

X2 voltage, V; 24 V nominal supply voltage application

Y maximum multiplying factor of R_{on}

Figure 4 — Variation of on resistance

4.4.7 Case temperature

The switch shall be fully functional in the case temperature range of –40 °C to 125 °C.

Some parameters may vary, e.g. the switching current or the on resistance.

5 Test methods and requirements

5.1 Switching

5.1.1 Switching at normal conditions

5.1.1.1 Test

The switching test shall be performed under the following conditions.

a) Power supply voltage: 13,5 V ± 0,5 V (27 V ± 1 V).

b) Power supply characteristics: in accordance with Annex B.

c) Load model: bulb (see Annex C), or

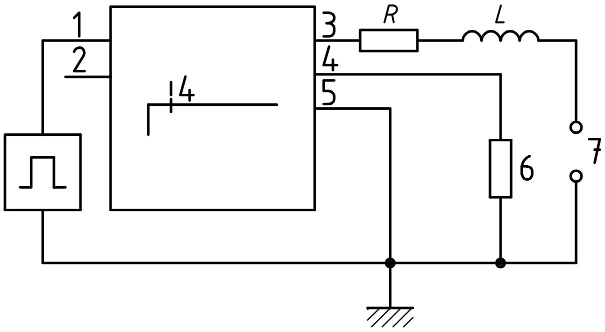
$$R = \frac{13{,}5}{I_{\text{rate}}} \quad \left(R = \frac{27}{I_{\text{rate}}} \right)$$

where I_{rate} is expressed in amperes.

d) Ambient temperature: (23 ± 5) °C, under free air conditions.

The switching test circuit shall be in accordance with Figure 5.

The switching characteristic, $\frac{\mathrm{d}I}{\mathrm{d}t}$, taken into account, shall be the largest of the measured values.



Key

Terminals of HSIPS

1 input

2 status

3 power supply

4 to load

5 Ground

Connected functions

6 load model (see 5.1.1.1 and Annex C)

7 power supply

R < 5 mΩ (< 10 mΩ)

L 5 µH ± 5 % (10 µH ± 5 %)

Figure 5 — Switching test circuit

5.1.1.2 Requirements

The switching characteristic $\frac{\mathrm{d}I}{\mathrm{d}t}$, measured according to 5.1.1.1, shall be in accordance with Table 5.

Table 5 — Switching requirements at normal operation

Switching mode	$\frac{\mathrm{d}I}{\mathrm{d}t}$ A/µs
Switching on	< 0,5
Switching off	< 3

5.1.2 Switching at short-circuit

5.1.2.1 Test

The short-circuit switching test shall be performed under the following conditions.

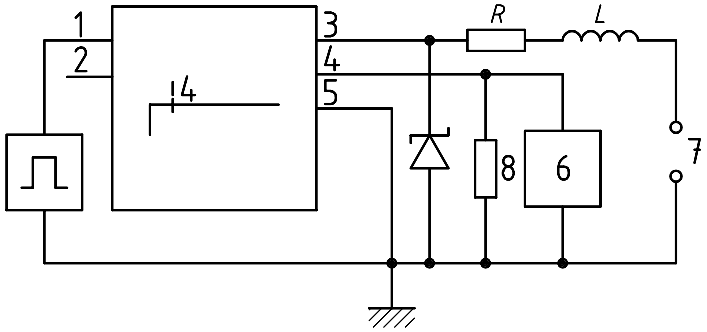
a) Power supply voltage: 13,5 V ± 0,5 V (27 V ± 1 V).

b) Power supply characteristics: in accordance with Annex B.

c) Short-circuit load model: in accordance with Annex D.

d) Ambient temperature: (23 ± 5) °C, under free air conditions.

The switching test circuit shall be in accordance with Figure 6.



Key

Terminals of HSIPS

1 input

2 status

3 power supply

4 to load

5 Ground

Connected functions

6 short-circuit model (see Annex D)

7 power supply

8 load

R < 5 mΩ (< 10 mΩ)

L 5 μH ± 5 % (10 μH ± 5 %)

Figure 6 — Short-circuit switching test

5.1.2.2 Requirements

The switching characteristics $\frac{dI}{dt}$ measured according to 5.1.2.1 shall be in accordance with Table 6.

Table 6 — Switching requirements at short-circuit

Switching mode	$\frac{dI}{dt}$ A/μs
Switching on	< 1
Switching off	< 3

5.1.3 Switching off inductive load

5.1.3.1 Test

Two tests of switching off inductive loads shall be performed at rated current I_{rate} and maximum continuous current I_{max}, under the following conditions.

a) Power supply voltage: 13,5 V ± 0,5 V (27 V ± 1 V).

b) Power supply characteristics: in accordance with Annex B.

c) Inductive load model: in accordance with Annex E.

d) Case temperature (85 ± 2) °C.

e) Test conditions at I_{rate}

1) Input frequency: 1 Hz ± 5 %.

2) "On" time: 5 L/R ± 10 % where L is expressed in microhertz and R in ohms.

3) Test duration: > 1 min.

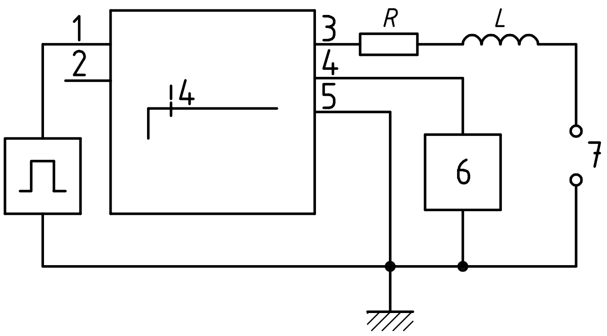
f) Test conditions at I_{max}

1) Input frequency: 1 Hz ± 5 %.

2) "On" time: 5 L/R ± 10 %, where L is expressed in microhertz and R in ohms.

3) Test duration: > 1 min.

The circuit for the switching off test with inductive loads shall be in accordance with Figure 7.



Key

Terminals of HSIPS

1 input

2 status

3 power supply

4 to load

5 Ground

Connected functions

6 inductive load model (see Annex E)

7 power supply

R < 5 mΩ (< 10 mΩ)

L 5 μH ± 5 % (10 μH ± 5 %)

Figure 7 — Switching off inductive loads

5.1.3.2 Requirements

After the tests in 5.1.3.1, the switch shall remain within its specification.

5.1.4 Short-circuit

5.1.4.1 Test

The short-circuit test shall be performed under the following conditions.

a) Power supply voltage: 13,5 V ± 0,5 V (27 V ± 1 V).

b) Power supply characteristics: in accordance with Annex B.

c) Short-circuit load model: in accordance with Annex D.

d) Minimum test duration: 1 min.

e) Ambient temperature (23 ± 5) °C, under free air conditions.

The switching test circuit shall be in accordance with Figure 6.

The clamping voltage shall be less than 50 V at maximum short-circuit current.

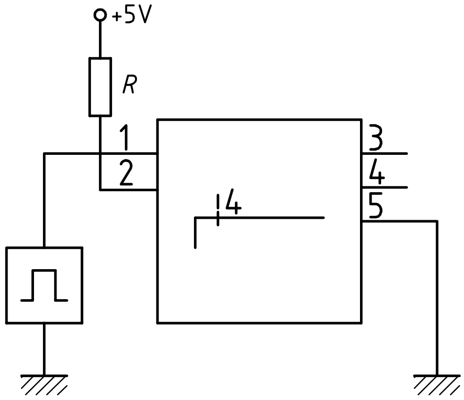
5.1.4.2 Requirements

The short-circuit test may be performed before or after switching on.

5.2 Status propagation delay

5.2.1 Test at open load

The test of status propagation delay at open load shall be performed with a power supply in accordance with Annex B and at a voltage of 13,5 V ± 0,5 V (27 V ± 1 V), measured using the test circuit shown in Figure 8.



Key

Terminals of HSIPS
1 input
2 status
3 power supply
4 to load
5 Ground

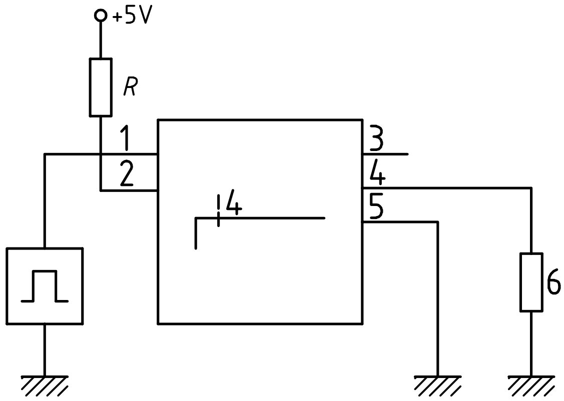
Connected function

R = 3 125 Ω, calculated by $\frac{5\ [\mathrm{V}]}{1{,}6\ [\mathrm{mA}]} \times 1\ 000$

Figure 8 — Status test circuit for open load

5.2.2 Test at overload

The test of status propagation delay at overload shall be performed with a power supply in accordance with Annex B and a voltage of 13,5 V ± 0,5 V (27 V ± 1 V), measured using the test circuit shown in Figure 9.



Key

Terminals of HSIPS
1 input
2 status
3 power supply
4 to load
5 ground

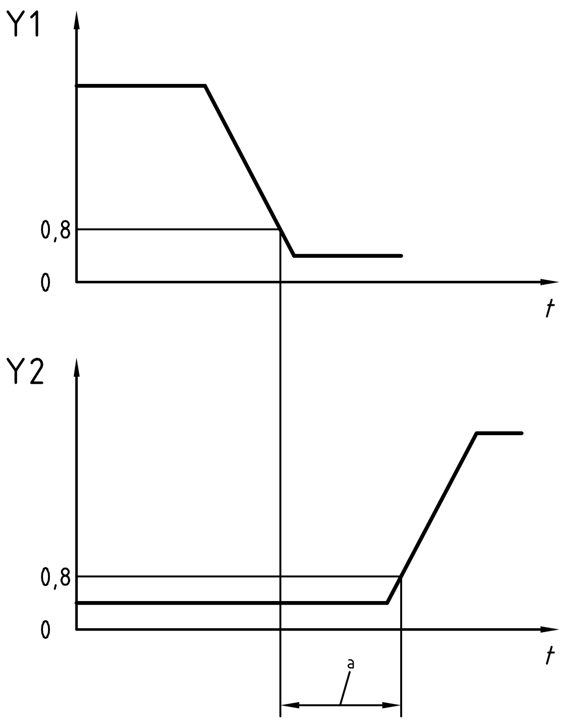
Connected functions
6 short circuit model (see Annex D)

R = 3 125 Ω, calculated by $\frac{5\ [\mathrm{V}]}{1{,}6\ [\mathrm{mA}]} \times 1\ 000$

Figure 9 — Status test circuit for overload

5.2.3 Requirements

Propagation delay time at open load and propagation delay time at over load according to 5.2.1 and 5.2.2 shall be in accordance with Figure 10.



Key

t time
Y1 input voltage, V
Y2 status voltage, V

[a] t_{pol} or t_{povl}.

Figure 10 — Propagation delay time measurements

Annex A
(informative)

Truth table

Table A.1 summarises the logic relations of the input, status and load terminal states of the high-side intelligent power switch at normal, open load and overload operating conditions.

Table A.1 — Truth table

Condition	Input	Status	Load
Normal condition	1	1	1
	0	0	0
Open load condition	1	0	0
Overload condition	1	0	0

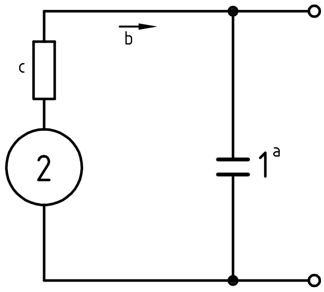
Annex B
(normative)

Power supply characteristics

The purpose of the power supply characteristics is to ensure repeatable tests of the switching behaviour ($\frac{dI}{dt}$, thermal behaviour, etc.).

Values are given for systems of 12 V (24 V) nominal supply voltage and at (23 ± 5) °C.

The power supply shall be as shown in Figure B.1 with output voltage as specified in the particular test procedures.



Key

1 capacitor, external: 100 mF

2 power supply generator

[a] For the capacitor, the equivalent series resistance (ESR) shall be $\leqslant$ 10 mΩ.

[b] $I_{max} \geqslant$ 50 A.

[c] Generator impedance, Z_i: $<$ 1 mΩ at $f <$ 100 Hz; $<$ 10 mΩ at 100 Hz $< f <$ 1 kHz.

Figure B.1 — Power supply characteristics

Annex C
(normative)

Bulb load model

The purpose of the bulb load model is to test switching behaviour ($\frac{\mathrm{d}I}{\mathrm{d}t}$, thermal behaviour, etc.).

The load model for a bulb shall be as shown in Figure C.1.

The values given in Table C.1 are valid for systems with nominal 12 V (24 V) supply voltage and (23 ± 5) °C.

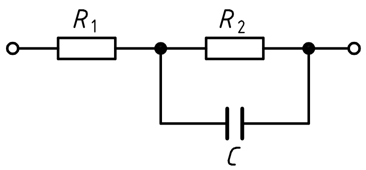


Figure C.1 — Bulb load model

Table C.1 — Bulb load model values

Bulb power W nominal	R_1 Ω ± 5 %	R_2 Ω ± 5 %	C [a] µF ± 5 %
55/65 (70/75)	0,17 (0,6)	2,3 (9)	33 000 (5 200)
21	0,6 (1,9)	6,2 (27)	5 200 (1 000)
5	2,4 (10)	27 (110)	400 (250)

[a] For the capacitor, the equivalent series resistance (ESR) shall be ⩽ 10 mΩ.

Annex D
(normative)

Short-circuit load model

The purpose of the short-circuit load model is to test switching behaviour ($\frac{\mathrm{d}I}{\mathrm{d}t}$, thermal behaviour, etc.).

The resistance given in Figure D.1 is valid for systems with nominal 12 V (24 V) supply voltage and at (23 ± 5) °C.

The short-circuit modal shall be as shown in Figure D.1.

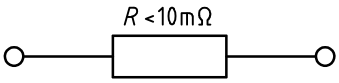


Figure D.1 — Short-circuit model

Annex E
(normative)

Inductive load model

The purpose of the inductive load model is to test switching off behaviour ($\frac{\mathrm{d}I}{\mathrm{d}t}$, thermal behaviour, etc.).

Values are given for systems of 12 V (24 V) nominal supply voltage and at (23 ± 5) °C.

The inductive load model shall be in accordance with Figure E.1 and Table E.1.

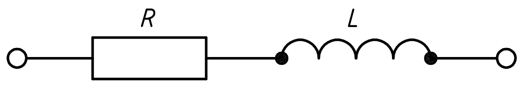


Figure E.1 — Inductive load model

Table E.1 — Values of inductive load model

Inductive load model to test at	R Ω ± 5 %	L
I_{rate}	$\frac{13{,}5}{I_{rate}}$ $\left(\frac{27}{I_{rate}}\right)$	To be specified by the semiconductor manufacturer
I_{max}	$\frac{13{,}5}{I_{max}}$ $\left(\frac{27}{I_{max}}\right)$	

Bibliography

[1] ISO 12343, *Road vehicle — Symbols for electrotechnical diagrams*

ICS 43.040.10

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